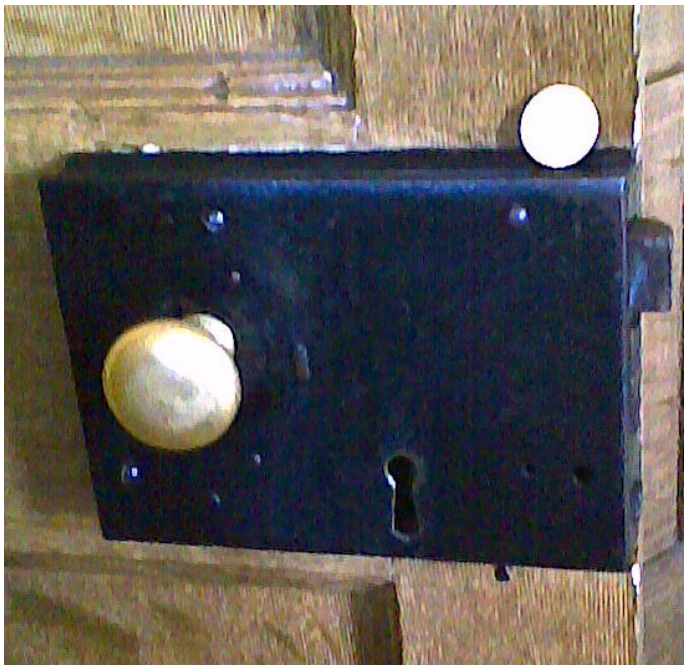
Warded door locks in Britain

a brief guide for locksmiths



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Warded door locks in Britain: a brief description for locksmiths

I grew up with warded locks. On my 1930's estate, every house I knew had a warded rimlock on the back door. My Grandfather's 1911 terrace house had a warded lock on the front door as well as the back. Most padlocks I met as a boy were warded. Many internal door locks were also warded. My Father's 1930's diy manual still described how to fit a warded front door rimlatch.

Whilst manning the Lock Collectors' stand at a lock exhibition, I chatted to a locksmith who told me of drilling a lock to pieces to open it – then finding, when he had it open, that it was a warded lock. In some places, such as 'new towns', warded locks are unlikely to be encountered. Yet they are still in very widespread service, sometimes being called 'heritage locks', (and sometimes just 'old-fashioned') and some locksmiths will need to be able to work on them. In particular, opening most that will be encountered is generally not as difficult as with more recent locks.

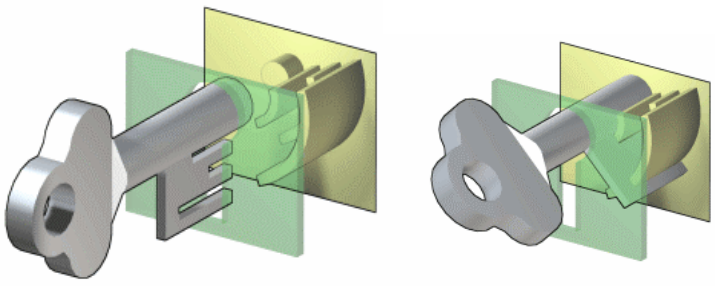
Around the country, there are houses, churches, and institutional buildings, particularly from the last two or three centuries, which need sympathetic maintenance, occasional refurbishment, and sometimes alterations for a change of use. Listed buildings and conservation areas can necessitate keeping old locks and door furniture in service. These days, there are not so many locksmiths with knowledge of old locks, and able to recognise old locks of good quality which are still secure. Elsewhere, modern security needs to be added sympathetically. The labourer is worthy of his hire, and working on heritage locks, even just 'old fashioned' locks, can mean business.

A little technical and social history

A little technical and social history can give useful clues to an unfamiliar lock.

After the Roman era, locksmiths relied solely on WARDS (fixed obstructions in a lock) as the principle of security, until Robert Barron invented the double-acting movable detainer in 1774. Although there was a stream of inventions of more secure lock types from then on, millions of warded locks continued to be made and many are still in use. Until late in the 19th C, many patent locks were scarce, or simply too expensive, or both, for many customers. Warded locks continued to be used in great numbers, into the first half of the 20th C.

A ward is a fixed obstruction built into a lock which prevents wrong keys from fitting into, or operating fully, to open a lock. The correct key is suitably shaped, or cut, to pass the wards in the lock. The various types of ward will be described below.



Warded lock principle, using wheel wards.

An architectural historian quipped to me that 'there are no old doors in London, since the Great Fire of London' (1666). It depends what one means by old … . Around the country,

there are some centuries-old warded locks still in service, in old universities, churches, castles, and 'country houses'. And the grandest example is on the two magnificent wooden doors giving entrance into the thirteen metre square Great Hall, front entrance of the grandest 'country house' of all – Blenheim Palace (1722). The lock and its huge key – the Coronet Key – were added to the oak front door in about 1825. Blenheim legend says that they were copied from a lock on one of the royal gates at Warsaw after being admired by the 5th Duke of Marlborough. He is said to have sent British locksmiths to the palace to make these perfect copies.

Throughout Britain's history, there have been various building booms, and slumps. Yet through time, the population has been increasing (apart from the mid-14th C crash caused by the Black Death). In the mid-18th C it began its rapid rise. Less well-recognised than the Industrial Revolution (c1760-c1830) which followed it, there was an Agricultural Revolution (1750-1900). A series of enclosures, the last at the beginning of the 19th C, made possible a dramatic increase in agricultural production. But enclosures forced many poor folk out of the countryside into the towns. Increased food supply fuelled a dramatic growth in the population, most of which was in towns.

In the countryside, many new farmhouses were built as farms became bigger. The farmhouse had to accommodate not only the farmer's (often large) family, but also the young single farm labourers. Also, assisted by various new laws, many substantial and elegant new parsonages were built for new or rebuilt churches. These parsonages were generally well-built, big enough to accommodate the rector or vicar's own family, and also, often, one or two curates, and an office. Some Anglican parsons had some private means, so could initially afford large parsonages. The Church of England began to sell some of these large parsonages from the 1920's onwards.

In mediæval and post-mediæval towns, which were rarely really crowded, (except those constrained within town walls), rich and poor had lived closely together. But as soon as towns began to expand and become more crowded in the mid-18th C, the wealthy, such as merchants, and later, manufacturers and professional men, began to move out of the town centres.

There soon developed around many towns, especially to west and south, a belt of substantial villas, extending from the old town boundaries out to about an hour's commuting distance. In level country, a horse-drawn carriage at a smart clip could go seven or eight miles. Most of these developments were later engulfed in the towns' expanding suburbs, though they are still recognisable today.

From the mid-19th C, the expanding railway network extended an hour's commuting distance to forty or more miles from the big cities. The wealthy middle class merchants and professional men could now live in a pleasant little county town – or even right out in the countryside, if near a village station – yet be able to commute to work in the big city. Many small towns in the hinterland of big cities rapidly developed broad straight streets of good villas near to the railway station.

Many of these detached houses had servants' quarters (even a servants' annexe); and those beyond walking distance of a railway station, often a coach house and stables. Substantial walled gardens were common. And from the cellar to the attic, millions of doors were fitted with warded locks. Even many of the front doors were, too. In those days, size impressed, so there are many large door locks, especially on house front doors, and non-domestic buildings such as churches, and other institutional building entrances.

These substantial houses are still popular for the original reasons. However, many are too large for modern families, and so have been converted to flats, and houses in multiple occupancy. Others are now guest houses and hotels. They are also popular with developers,

who like to demolish the original house and infill the site's walled ground with higher-density housing.

Many towns had some regulations to regulate building in towns. These were mainly concerned with fire protection, and 19th C laws were also mainly about public health. Until the 20th C there were few restrictions on building in the countryside, and a landowner could build where and what he liked and could afford.

The 1909 Town Planning Act required builders to build to a certain standard, but this only applied to new houses – and building would soon come to an abrupt halt! A succession of housing and town planning acts followed after the Great War, in 1919, 1925, 1932. Rural planning was only introduced in 1932, and a 1947 act clamped strict controls on building in the countryside. There were building guidelines from 1936, varying from town to town.

In the post-World War 2 housing shortage, many corners were cut. Internal doors became thinner, lighter, less substantial, and locks vanished from them. Indeed, much of the wide variety of warded door locks ceased production in 1939-40. Four-lever mortice deadlocks continued to be widely used, until the BS3621 locks appeared from 1963 onwards.

Despite the high crime rate, including burglary, when the war ended, high quality door locks were not uppermost in the minds of many of the population after WW2. Some would have been glad to even have a door of their own. Even more so, a roof over their heads. (Bomb blast, even if it did not completely destroy a house, blew out (or in) the windows and doors, and stripped the roof. Although it was government policy to repair all damaged houses as quickly as possible, it was years before all this was achieved. In the cold winters following the war, with coal rationed, wood was scrounged from bombsites, including unoccupied buildings only slightly damaged.)

In the mid-1960's, national building regulations appeared for all parts of the United Kingdom. Concern about house security developed greatly from the 1980's, with various Home Office crime prevention campaigns, and police initiatives leading to such schemes as *Secured by design*.

Catalogues and advertisements of the 19th and early 20th C show the wide range of warded locks and keys made in great numbers; and a glance around surviving buildings from earlier times shows many still in service.

It is true that by the 18-19th C, some burglars knew the details of skeleton keys. Also that most warded locks can be quickly opened by a suitable skeleton key. Notorious lockpickers such as Jack Sheppard in London in 1724, and Deacon Brodie in Edinburgh in 1788 (his lockpicks are in an Edinburgh museum) for example. However, in the past, the most prevalent threat was not a skilled attack, but brute force. Although many modern locked doors will fall off their hinges with a couple of taps from a one-man battering ram the size of a fire extinguisher, many older doors and their locks were made of stronger stuff. Making 'a suitable skeleton key', if one is not available, is not necessarily a quick task, but unlike picking movable detainers, it can be interrupted any number of times, and *resumed where it left off*.

In the modern world where thieves no longer carry the sometimes large and specialised picking tools needed in the past, a good warded lock might today present better security than it did two centuries ago. There are advantages to being unique or different. The greatest disadvantage of mass-produced locks, no matter how well made, is that those who wish to circumvent them have greater opportunity to obtain samples to dismantle, develop tools, and to practice upon them.

Although many locksmiths today disparage wards, they are an important part of the security of most cylinder locks. Indeed, those with experience of both the more open US keyways, and the relatively restricted keyways of European locks, concur that the restrictive warding makes

these a greater challenge to pick. There is also further scope to enhance the security of lever locks by the use of more wards as was done in the past.

Wards are often considered poor security, but imagine inserting a full bridge ward in a BS lever lock, and locksmiths would all need to buy 3-in-1 curtain picks as well. Or the addition of a sash ward on the inside of the cap of a BS lever lock would block a pin & cam system!

This article looks at four common types of warded door lock. There are exceptions to most generalisations, but this should cover many of the warded door locks which might be encountered.

Banbury stock lock

Until the 20th C most door locks were rim locks. The Age of Mahogany (mid-18th C) prompted the development of the mortice lock, but mortice fitting was time-consuming and expensive, requiring quite thick doors, and so was initially uncommon even in high-status buildings.

Typical Banbury stock lock and key, 19th C (Author's collection, left)

Single-sided stock lock on the 13th C door of St Mary & All Saints, Dunsfold, replacing an original, smaller, lock. (right). This one is unusual in having a pipe key. The escutcheon was formed by folding a piece of parchment to cut half the keyhole shape, then again for cutting the pattern of one side.

Keyhole of St Mary & All Saints, Dunsfold, showing individually handmade escutcheon.

Many low-status buildings, farm outbuildings for example, and cottages, had often locally-made locks called 'Banbury stock locks'. The reason for the name Banbury is unknown. The town is not otherwise associated with lockmaking. This type of lock was once widespread. There is no metal lock case, nor even a metal baseplate. All the simple

components are set directly into a block of wood which has been cut out to receive them. Making Banbury locks requires little skill of either blacksmith or carpenter. Commonly, odd offcuts of wood were used for the stock, so many different types of wood are found. Sometimes they were only roughly squared, and (especially older ones) might even roughly resemble the shape of a gunstock. The cut-outs were originally made by hand with straight chisel cuts. Later commercial-production locks sometimes have circular cut-outs made on a drilling machine. Banbury locks have the merit of being less prone to condensation than metal locks, which was an additional reason for their popularity.

Like most other two-sided warded rimlocks, Banbury locks have a bridge ward, usually fitted with fine wards. (See below for a description of fine wards.) Uncommon forms of Banbury have also been made, as single-sided; and also with 2 deadbolts. These use either a double-bitted key or a single-bitted key with 2 turns. They use, like most of the warded locks discussed here, a single tumbler spring-impelled to drop into notches in the top of the bolt-tail to lock the bolt in either the thrown or withdrawn position. There have been made only a few more sophisticated Banbury locks – you will be uncommonly fortunate (or unfortunate) to encounter one!

A few Banbury locks were single-sided, most of these also used pin keys, but the one at St Mary & All Saints Dunsfold is a pipe key lock, of slightly later date than the door.

Some Banbury locks were made by local blacksmiths, but for centuries there were locksmiths making them in Willenhall, the centre of the British lockmaking industry. During the 20th C however, the largest maker was the firm of Thomas Crompton and Sons Ltd, Ashton-In-Makerfield, near Wigan. Their main business was hinges and other ironmongery. Their factory made various locks, until about 1963. Banbury stock locks and wood stock locks were made until 1954. Their trade mark was TC in a circle.

The peculiar feature of Banbury stock locks is that there is no keyhole in the case on which the collar of the key can rest – so the collar rests on the bridge! The collar is, therefore, up against the collar ward cut, half way along the length of the bit. Banbury keys are thus distinctive. Most of the Banbury locks that will be encountered are more or less old (mainly 19th or 18th C). However, Thomas Crompton, probably the last commercial maker of stock locks, made some 20th C Banbury locks with a bushed keyhole, so the key did have its bearing there, as in other locks, instead of on the bridge ward.

Old locks were sometimes nailed to doors with long (handmade) nails which went right through the door and then were clenched over on the other side of the door. This makes them difficult to remove even for maintenance, and locks are commonly discarded when doors are removed. Removal, if needed, usually involves breaking such nails. Incidentally, oak is corrosive to iron, and some locks do therefore suffer corrosion, especially of the bridge, this being relatively thin iron.

Stock lock

Many early metal rimlocks had no case to cover the mechanism – and many were single-sided latches, with some sort of handle or finger-pull operation on the inside. Some have a wooden stock fitted. It is called a stock, by analogy with a gunstock which acts as a holder/container for the mechanism. Stock locks (also called plate locks or plate stock locks) have the mechanism mounted on a metal backplate, and let into a cavity in a block of wood. The name ‘plate stock lock’ was probably to distinguish these locks which have the mechanism fitted on a plate, from Banbury stock locks, which have no such plate. They are usually deadlocks, sometimes of large size. Some have some decorative trim on the wood stock. Many were used on low-status doors, country cottages and outbuildings.

However, there is a variety of stock lock which was not intended for low-status use. The 'church door lock' is (usually) a two bolt rim stock lock, with metal bands or other decoration in ecclesiastical style. Especially during the rapid population growth of the 19th C, there was a large amount of building and rebuilding of Anglican churches, and schools, often in gothic revival style. Church door locks, often of large size, were popular fittings, and many are still in service. (Nonconformist chapels preferred plain iron cased locks.) Church door locks were also popular for many of the gothic-style country houses built in the 19th C. Many other churches, however, especially older ones, have single-bolt stock locks.

Apart from the absence of a metal case and coverplate, the mechanism of most of these warded door locks is similar to other warded rimlocks. Many locks, and most of the earlier ones, have fine wards (see below).

Most stock locks, indeed most locks encountered by most locksmiths, will be no more than a couple of centuries old. Yet both forms of stock lock have been known for much longer. This stock lock has been on the door of Albury church since 1240, when the Normans rebuilt the old Saxon church, and is still in service. A porch was added three centuries later to protect the door.

Stock lock on door of St Mary's church Albury, from 1240.

Rim lock

It is likely that many readers will have seen a picture of the superb brass 'cavalier locks' made in the late-17th C by John Wilkes of Birmingham – there are two of them in the Victoria & Albert Museum, and in 2002 another was sold from a private collection for £25,000. They are, however, unusual (!). Much more common is the iron-cased lock, made with only slight variations from the 17th C to the early 20th C.

Iron cased rim locks began to be common on main doors from the 16th C. There is a bolt with two notches in the top of the bolt tail. There is one tumbler, with a projecting stump. The tumbler is impelled by a spring so that the stump rests in either one of the notches, thus deadlocking the bolt. When the key is turned, its bit first contacts the tumbler belly and so lifts the tumbler stump out of engagement with the bolt, then carries the bolt to its new position. Further turning of the key allows the tumbler to fall and hold the bolt. It is only necessary to lift the tumbler far enough to disengage it – overlifting has no effect. Hence this tumbler is called a 'single-acting' tumbler. The spring is typically a wrought iron scotch spring. In most older locks the tumbler is fixed on a short stump under the bolt. In later locks, and more

commonly mortice locks, it might be placed on top of the bolt tail, more like a conventional lever, and have a spring of flat steel wire.

In other locks the form is slightly varied. Instead of the tumbler stump dropping into notches on the top of the bolt tail, it abuts a stump on the underneath of the bolt tail. There are some other detail variations of form, but the principle of one single-acting tumbler remains.

Security of the lock resides in wards – fixed obstructions. Mostly, these are inside the lock, but some, mainly European locks, have only bullet wards around the keyhole – see below for bullet wards.

In bridge ward locks, the bolt talon is one side of the bridge and the tumbler belly is the other side. So the bit has to be in two parts, or for picking, two pieces are needed.

Typical 19th C warded rimlock keys with bridge ward, showing , left, fine wards, and right, solid wards, forming part of the communion rail of St Peter's church, Chillingham. The rail was made in 1967.

A little metallurgy

Until the second half of the 19th C, steel, especially steel suitable for making springs, including clock and gun springs, was in short supply and expensive. In the early 18th C, Sheffield produced only about 200 tons of crucible steel, mainly from iron imported from Sweden (Swedish ore happens to be uncommonly low in common impurities). Cort's 1784 puddling process using a reverbatory furnace increased the supply of wrought iron somewhat. The Bessemer converter (1856) had some problems initially, but when it eventually began to operate on a large scale, it enormously increased the production of mild steel whilst dramatically lowering its cost. By 1870, it became cheaper than wrought iron, whose production thereafter declined. Cast steel (crucible steel), though expensive, remains in use for the most demanding purposes.

Until around the middle of the 19th C, most cheap locks used scotch springs. These are hammered wrought iron, almost straight, flat and fairly thick. One end is riveted into the lock case, the free end is slightly curved and thinned. As they are not very flexible, they are placed to bear against a moving member near to its pivot, where the movement is small. Scotch springs are generally stiff and strong. They are not too prone to rust, scarcely suffer fretting corrosion (unlike modern flat steel wire springs) and breaking is uncommon, though not unknown. They can also lose their springiness.

Some springs were, mainly from the 19th C, made of brass or bronze, before spring steel was abundant. These copper alloys are softer and weaker than steel — such springs are less stiff (and so store less energy) for the same bulk. Bronze resists corrosion and metal fatigue more than steel, so bronze, usually as phosphor bronze (containing up to 1% phosphorus), is still used for some springs.

Until the early 17th C, English metallurgists could not make good brass, which therefore had to be imported from Europe. Some European metallurgists were even recruited to tackle the problem. Eventually the considerable problems of using British ores were solved, and brass

became more abundant, and somewhat less expensive (though still not cheap). Abraham Darby (1678 – 1717) developed the process of sand moulding that allowed iron and brass goods to be mass produced at a lower unit cost. From the late 17th C, numbers of high quality brass rimlocks were made, and today these are much sought after in conservation areas.

Some of the brass rimlocks with plain polished cases have a type of concealed fixing, with the screws only visible on the foredge when the door is open. This type of concealed fixing re-appeared in some cylinder rimlatches from the 1970's.

Just as an example, the accounts of the building of a country house in the mid-18th C show:

2 x 9" brass door locks @ £1-16-0

1 x 9" brass door latch @ 16/-

1 x 8" brass door latch @ 15/-

2 x 7" iron door locks @ 12/-

1 large iron door lock @ 6/-

The iron locks would have been for outer doors, the brass for interior ones. To put the prices in perspective, a single-plate cast-iron strongroom door for this house cost (presumably including its box-of-wards lock) £9-18-4. A typical skilled workman's wage would have been about fifteen shillings a week. The ironmonger who supplied this strongroom door had a small provincial foundry, and although withdrawing from the strongroom and safe market by about 1870 in the face of competition from more modern wrought iron/mild steel safes, only ceased trading in 2011.

Locks made for marine use from the 18th C onwards are generally brass or bronze, and usually have bronze keys. For no obvious reason, ships' door locks generally have flanges for fixing. Brass locks with copper wards and brass or bronze keys were also made for gunpowder magazines, to avoid sparks. Magazine locks are single*sided with a pin key, and both latches, deadlocks, and deadlocking latches were made..

Rim locks have no particular constraint on their size, unlike mortice locks, whose case thickness is limited by the thickness of the door. Most two-sided warded rim locks have a bridge ward. This is mounted on supports at either end, in the middle of the lock case. There are two methods of making bridge wards (this does not affect how they are used or the locks opened). Rim locks can be deadlocks, latches, or two-bolt locks. Deadbolts lock with one single-acting tumbler, usually fixed to the case or backplate, under the bolt, and impelled by a strong scotch spring. Latch bolts are normally impelled by a scotch spring at the end of the case furthest from the forend. On older locks, the coverplate covers only a small part of the lock, over the area of the bridge ward. On later locks, when the supply of iron had increased, the coverplate covers the whole of the lock.

Bridge wards

Bridge wards are a bridge in the middle of the lockcase, carrying either fine wards or solid wards.

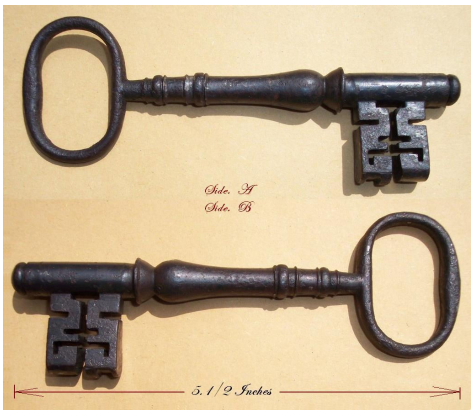
Fine wards are wards made of sheet metal (originally wrought iron, later sometimes tinplate; copper was used for locks intended for damp situations and gunpowder magazines) fixed into the edges of the bridge. They may be straight, hooked, or various other shapes. They are riveted in notches in the edge of the bridge, or assembled by brazing. One ward in the centre of the bridge acts as a bush to support the key. Similar sheet metal wards may be fixed to either the backplate or cap of a lock, or both. These are usually called wheel wards in single-sided locks, and padlocks. They may be complete (found as soon as a blank tries to turn), or incomplete (at the side of the keyhole and so found only when a key has made a

partial rotation). On single-sided locks, a complete wheel ward will prevent a wrong key (or blank) even entering the lock. In two-sided locks, such wards fixed to the case or cap are called sash wards.

In high-quality older locks, fine wards could be very intricate. It is possible to design overlapping wards such that they are difficult to skeleton, (without the key bit separating). This is mainly seen on single-sided locks. It does tend to make keys seriously weakened and prone to damage. Hence it is mainly seen on small cabinet keys, and large, thick-bit keys.

Key for a large mid-19th C rimlock with overlapping hook wards. (Author's collection)

The plainness of this thick bit key suggests it might be a later copy – but all the cuts have been chiselled by hand on the arcs of the wheel wards, exactly as old keys were cut. Locksmiths would allow 'several days' for such keys, for 'box of wards' locks, such as for old iron safes and armada chests.

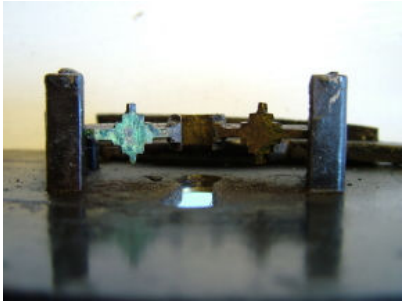


Early 19th C rim key of high quality.

This lock actually has the sash wards that have cuts on the key; notice also the bit has a groove worn by the strongly sprung locking tumbler – the key was only used from one side.

Many rim keys have ward cuts on the edges suggestive of sash wards. However, it is common for no matching wards to be actually present in the lock. This deceitful practice was common on later locks, when customers had no understanding of locks. If sash wards *are* present, it is common to find wards only on the backplate, *or* the coverplate, though rarely both. The older and larger the lock, the more likely sash wards are to be actually fitted. They are also likely to be actually present in church door locks of any age. These sash wards are particularly effective at frustrating simple skeleton keys, but were extra work for the locksmith. In a cottage industry where workers were paid piece-rates, such shortcuts were not unusual.

Sash wards actually fitted often do not need such deep (or wide) ward cuts as were often made, so the key is weakened more than necessary – something to bear in mind when copying or fitting keys.



Solid bridge wards seem to have been introduced by a Mr Toy, about 1816.

A solid bridge ward, left.

Solid bridge wards are a one-piece brass casting, finished in a lathe, and were considered superior to fine wards. They offered more opposition to a key, and made more work for anyone altering a key to fit. They were made in a large variety.

Most single bolt locks which might be encountered are dead locks. There are some however, which are springlatches. They may be key-operated from both sides, or one side only (the most common); or 'to lock and spring'. This is a springlatch which, by a turn of the key, has a further shoot, and is then a deadlock. They are also called deadlocking latches. Mostly, the two-sided ones are made much the same as deadlocks, with a bridge ward.

In the late 19th C and early 20th C there were also some small case rimlatches, mainly intended for the emerging fashion for glazed doors (glass was becoming more abundant, and cheaper), either as the outer front door, or an inner entrance door. Many of these use sash wards, though there were also some lever latches. After the Great War, their place would increasingly be taken by pin tumbler cylinder rimlatches, as British production of these increased.

Up until about the end of the 16th C, latches were often made with a 'box of wards', often in a form which did not allow the key to make a complete revolution. Although such wards were still used on armada chests into the early 19th C, they are unlikely to be found on door locks of the last two centuries.

'Hatchet' rimlatch 16th C

This rimlatch is on a private extension of the 16th C to a much older Home Counties manor house. It is pipe-key operated from outside in a box of wards (under the oval plate), and the inside end of the bolt is turned up (outwards) as a finger pull. Typically, the latch has no case covering it, and would originally have been nailed on. This latch, uncommonly, has a square bolt – the bevel to operate it is on the doorpost.

In Britain, most lock cases were of wrought iron until late in the 19th C, unlike the American practice of using cast-iron. Cast-iron is less stable dimensionally, and either the case needed fettling, or parts needed fitting by hand. Wrought iron cases were not so cheap to make but needed less hand fitting, especially once machine-made interchangeable parts became common. Mild steel stampings were even cheaper and quicker to make.

Drill pins

Although most door locks which will be encountered are double-sided, there are some single-sided ones. The late 19th C small case latches are often knob-operated on the inside. Some early latches also are single-sided. Some locks intended for outbuildings and buildings only locked when nobody is inside, such as churches, might be single*sided. This makes possible the use of a pipe key. In such locks, the drill pin is in effect another ward. Typically, large diameter drill pins are short, just the height of the lockcase. Small diameter drill pins are longer, often pointed/tapered, and protrude well out of the lock case – this helps with inserting a key through a thick door. Pipe keys should be drilled only as wide and deep as needed to fit the lock. Thus, a small diameter pipe will be too small to fit over a large diameter drill pin, but a large diameter pipe is not drilled deep enough to fully enter a lock with a small diameter pin.

Mortice lock

Warded mortice locks were widely used for more important interior doors later in the 19th C, and might also be found on exterior doors. However, by now, today's insurance requirements will usually have compelled the fitting of something more modern on final exit doors, for normal use. Warded mortice locks remain in widespread use on interior doors. Right up to the

1930's, many interior door locks rely as much or more on wards as levers. Quality ranges widely from quite good, to poor. Later locks were often mild steel stampings.

Mortice locks need cases thin enough to fit in a door. Thick doors are expensive. The majority of warded mortice locks therefore use sash wards, apart from gate locks.

Sash Wards

A collar at the centre of the ward serves also as a keyhole bush. A circular piece of metal (usually brass) is pressed into the lockcase around the keyhole. A spinning tool in the form of a flat cutter with a centre-bit then forms the circular hole for the key stem's pin, and forms a pattern of solid wards around the keyhole. A slot is cut for the key's bit, forming the typical bit key 'keyhole'. A large variety of sash ward patterns has been made. There are also sets of sash wards all different, but with a master pattern to pass them all, whilst yet not being completely skeletoned. These were much used with wide-gated levers for cheap off-the-shelf master key suites in non-domestic buildings, e.g. schools, into the 1960's.

Sash wards are also commonly used in older lever locks.

Much less common were mortice locks with a bridge ward. It was possible, but they were more expensive than sash wards.

Early 20th C mortice lock with bridge ward, and lever-like single tumbler. (Author's collection)

A popular application for warded mortice locks in Victorian and Edwardian times was garden gate locks, especially on front garden iron gates. They were practically unrestricted in case thickness, unlike locks in wooden doors. Many of these used bridge wards. Though many gate locks remain in situ, seemingly few now work. They also often had a remotely-operated cable release from the house.

Rim (above) and mortice (below) bridge ward keys, late 19th C. Notice the points of weakness where the sash wards are adjacent to the hook wards on the bridge of the lower key. (Author's collection)

The illustration shows a bridge ward rim key (above), and (below), a mortice key from a door in a 19th C police station, where the expense of having a thick door would be likely. Locks this large were usually used as gate locks. Both these keys have fine wards (some of which are hook wards); the mortice key also has sash wards. A few later warded locks, both mortice and rim, have a single tumbler similar to a lever, but usually open at the bottom. It is on top of the bolt tail, and usually pressed by a flat steel wire spring.

Free floating wheel wards

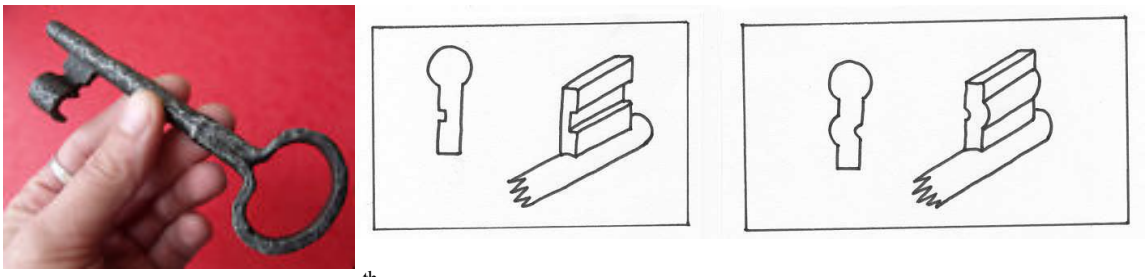
These are semi circular wards secured to the lock at one end. The key "threads" onto this ward but cannot make a complete turn, and therefore is used only for spring latches. The key cannot be removed until the lock is reclosed, like modern key retaining locks. This is often found in

higher security applications, e.g. chests (especially armada chests) and pre-16th C door latches using a box of wards.

All of the above wards may be used in various combinations for greater security.

Bullet (keyway) ward (*case ward*, US.)

Another type of ward possible is the keyhole bullet ward. Any shaping of the keyhole other than a plain slot is called a bullet ward. In much earlier times, this was a common practice. At the outset, it would exclude many wrong keys from even entering the lock. If (as is usually so), the keyhole is not symmetrical, no collar is needed to stop the key being pushed right through a two-sided lock. Such shaped keyholes continue to be widely used on European locks, especially cheaper ones. These bulleted keyways hinder the taking of impressions — a simple flat blank key cannot enter the keyway. Keyways were developed with shapes that in themselves were wards; especially popular in France was an S-shape.



Bulleted doorkey – French 17th C iron (left). Two modern bullet ward keys, which might be found in Britain, right (illustrations courtesy of Capt Duncan)

Simple bullets were common on early 20th C mortice locks with stamped steel cases. Most often a bullet ward protruded into the side of the keyhole, requiring a groove along the side face of the key. With perhaps three positions on either side, several useful differs were cheaply available. Many such locks, with one or two levers, were used in the housing boom of the 1920's and 1930's. Often the keys were diecast zinc alloy (Mazac). The converse, a ridge on the face of the key, requiring a notch on the side of the keyhole, was also possible. Some modern British lever mortice locks (especially 3-lever locks) with bulleted keyholes are still in use. However, today the main use for bulleted keyways is in pin tumbler lock cylinders.

Maintenance

If door locks need maintenance, the first problem with old locks might be removal. Wood screws were scarce and expensive before the late 18th C, so older locks are likely to be nailed on, unless they have sometime been already removed and refitted. Early handmade screws can also have poor or damaged driving slots, as they are much softer than modern screws. Unlike modern screws which are made by cold heading, early screws were actually cut – by hand, or on a lathe. Driving slots were cut with a circular saw are often off-centre. They are best approached gently with hand tools. When taking vigorous action on a screw or any mechanism, remember to use eye-protection.

It is helpful to pick away all paint around the screw head and slot – an awl is useful. Slots can be re-cut with a fine saw blade or file if accessible, otherwise, a Dremel might work. Carpenters' London pattern screwdrivers have a flat section at the top of the blade, and some engineers' screwdrivers have a hexagonal section at the top, both so that pliers or a spanner can be applied, to add torque whilst pressing on the end of the screwdriver. For large screws, I had a couple of screwdriver bits in a ratchet brace (some readers might need to ask their

grandfathers what that was) – easy to apply inward pressure to keep the bit in the slot, and massive torque. The ratchet brace is gentler than the next tool. A blow from an impact screwdriver might help. A touch of a hot soldering iron might or might not help release a sticking screw, and a little penetrating oil might help – remember penetrating oil is flammable. Screw extractors rarely work on small old screws. Drilling or grinding off the head might allow the lock to be lifted off, then the screw can be gripped with locking pliers and usually turned out – or drilled out. If all these fail, there might be nothing else but to prise the lock off.

This will usually be necessary for locks nailed on, unless the head can be removed. Clenched nails will need to be straightened, which will probably cause the end to break off. If possible, place a sheet of metal under whatever tool, e.g. jemmy, is used for prising the lock off, to protect the door surface.

Locks tend to have a hard life, usually with little or no maintenance. Possibly the commonest problem with old locks (especially on outside doors) is stiffness caused by dirt and rust. Be aware also that their nature is to have very strong springs, which makes them seem much stiffer than modern locks.

The subjects of cleaning and lubrication are large, and somewhat complex, and this is not the place to dilate on them, so only brief consideration can be given here. Today there is a wide choice of lubricants, using silicone, Teflon (PTFE), graphite, synthetic oils, and a molybdenum compound.

Today's lockmakers do apply grease to their products, but this is only satisfactory in the short term, and provided the air is fairly clean. In the past, town air was heavily polluted. Because of the inefficient burning of coal, the air was acidic and therefore corrosive of iron. It was also very dusty, with gritty ash. This grit, mixed in grease or gummy old oil, makes a very effective grinding paste. It is now preferable to use a dry lubricant, preferably with corrosion inhibiting properties.

Dirt and foreign bodies

Old locks, with their large keyholes, can accumulate much dirt, dust, soot, cobwebs, and sometimes a few other things. Feathers, small toys, and coins have all been found in old locks. The most I have found is one farthing, but silver threepence and sixpence coins have also been found.

A customer asked me to service her three-quarter century-old door lock, which had become very stiff. As the customer was a lady in her eighties, with arthritic hands, my first thought was, that it would be her problem. However, the lock certainly was stiff – and it was still stiff with the door open. Old locks, especially rimlocks, but also mortice locks, commonly suffer rusting, which, with dirt, makes them very stiff – but only needs cleaning. On opening this lock, however, the cause of the stiffness was immediately obvious. The lock contained a nest of a bee! All the space was filled with wax cells, some of which had been parasitised by a tiny (unidentified) parasitic wasp. The bee responsible is the red mason bee *Osmia rufa*, a solitary bee quite common in Britain. There have been several reports over the last century of its nesting in locks, though this is not common. The unaggressive bee is harmless to humans and does no damage, but is an important pollinator. Very large locks, such as on churches and castles, have also had small birds, usually blue tits, nesting in them.

Fit of door

When lock service is needed, much of it is the same for warded locks as for most other locks. That the door operates correctly and the lock aligns with its staple cannot be taken for granted

on older buildings, and wooden doors. Then the lock's operation must be tested with the door open. If the correct key is available, the lock must be tested for a half-shot bolt. It is common for a worn key not to throw the bolt fully, and a deadbolt must be thrown fully and deadlocked by the key. It should **not** be possible to push in the bolt by end pressure, nor to pull it out until it clicks.

The door dropping is a common cause of locks binding or being stiff to operate. However, it is rare for old doors to come apart, and need joints remade. The type most at risk of loose joints is probably the panelled door. Check for loose screws in the hinges, especially the top one. Heavy doors can pull out the screws of butt hinges. A longer or larger screw might be possible. If the thread is stripped, the hole can be plugged. Usually a matchstick is enough, or a plug can be whittled to fit from a hardwood dowel. Plugs can be glued into holes, but refrain from gluing in a screw.

Old doors mounted on pintles (or 'hook and bar') usually do not have problems with alignment, but if the door binds in its opening, usually the door can be removed and washers put on the pintles as shims. Normally, doors on pintles close behind the opening of the doorposts, rather than between, so alignment is not critical. However, they can drop enough to drag on the floor. It is usually a simple, though heavy, job to remove the door and add washers as shims.

Old buildings can move. It had already been recognised before WW2 that the foundations provided in current practice, especially for houses, were inadequate, especially on clay soil. The quaking effect of WW2 bombing can exacerbate poor foundations. This was remedied in later building regulations, but is something to be aware of in pre-WW2 buildings.

When buildings move, door openings are out of square and the door no longer matches the opening. With a really tight door it can be worth testing all round; or a small tight spot might already be obvious. To check where the door is binding, use a piece of photocopy paper about an inch wide and six inches long. Start in the top corner on the opening side and work your way around the door. Open the door, place the paper strip in the top corner. Close the door and pull the paper through. The paper should slide through easily. If it doesn't then mark the edge of the door with a penciled X. Move 2-3 inches away and repeat. Once all sides of the door have been checked and marked, assess whether trimming is needed. If so remove the door and trim marked areas – see below. Often, however, only spot treatment is needed.

Wooden doors might not be dimensionally stable. Slight sticking at the edges might be cured with a spray of silicone furniture polish. Below, I mention a more modern silicone lubricant spray. I also carried a stick of paraffin wax (a candle stub), but today there is something better available. *Door-Ease* is a white lithium grease stick for spot lubrication on surfaces such as metal, wood, rubber, plastic and glass that are sticking or squeaking. Used like a crayon, this is a convenient, clean, all weather multi-purpose product. The stick does not dry out, exude oil or crumble and is sufficiently dry to prevent catching excessive dirt and dust under normal conditions. It is ideal for lubricating sliding patio door and window channels, filing cabinet runners, door hinges, etc.. And whilst I'm mentioning it, it's also useful in the workshop for easing assembly of various parts such as screw and bolt threads.

Sandpaper or planing might be needed in worse cases. Many layers of paint on both door edges and doorframe might be the cause of a problem. I carried a small block plane, but electric planes are now cheap, quick, and less awkward to use. If much has to be taken off a door edge, it is preferable to trim the hanging style – this might need the recesses for butt hinges to be chiselled a little deeper. If the edge is taken back to bare wood, it needs to be painted to keep out excess moisture. The sort of spray sealer used for sealing stains on paint is a quick-drying paint suitable as a primer.

If the door closes easily enough but the bolt is no longer aligned with the striker plate, a small adjustment might be made by filing the bottom of the opening in the plate. A rotary file or a small grindstone in a small rotary power tool such as a Dremel®, can speed this. If a movement greater than half the diameter of the screw holes is needed, it is better to re-position the striking plate on the doorpost. This is mainly a problem with mortice locks. More difficult to cure is a door which has developed a wind – but that problem is unrelated to the type of lock. It often happens to a wooden door because different parts of the door absorb different amounts of moisture. On outside doors, the source of the problem is often that the **bottom edge of the door is unsealed**, unlike all the accessible edges.

Dismantling

Before dismantling an old lock (indeed, any old machinery pre-mid 19th C), examine the screws and their holes carefully. A workshop practice we take for granted today did not yet exist. Screws are generally not interchangeable on old locks. Each workshop had its own screw threads, screws and their holes were made by hand, and each screw could only be sure of fitting its own threaded hole. Each screw, and its matching hole, will be marked by dot punching. For example, on a lock case with 4 screws, the screws will be marked with 0, 1, 2, or 3 dot punch marks. These marks might be hidden by rust or paint.

Cleaning and refinishing old locks

Be aware that with historically significant locks, both the sequence of coatings, and their exact nature, can be important historic information, which possibly should be preserved. However, most old locks are not 'heritage' locks, they are simply old. Aggressive cleaning methods such as abrasives, work, but tend to be somewhat laborious and time-consuming.

Sometimes, locks are not so much rusty, as coated with old oil or grease, which might also be sooty. I have used Gunk® degreaser for years. Shake can before use and also during application.
Spray or brush the Gunk generously on the area to be cleaned until the area is completely wet – or use a bath. Leave for 10 minutes allowing Gunk to fully penetrate. If necessary, use a stiff brush to loosen stubborn deposits. Rinse thoroughly with a strong stream of water. Do not use on lacquered or painted surfaces otherwise discolouration might occur.

Grit-blasting works, and fairly quickly, but the cost of the equipment needed suggests jobs should be sent to a specialist contractor. This is a flexible method – it can also be gentle enough for museum conservation.

For light cleaning, the plastic mesh pot-scourers originally sold for kitchen use are safe. Indeed, they are so useful in the workshop that 3M later packaged a range of grades for workshop use.

Whatever method of cleaning ironwork is chosen, it is important to bear in mind that the removed material might be highly toxic. In particular, historic paint might contain lead and other heavy metals, with implications for both personal health and the environment. When planning the work, consideration must be given to the control and disposal of all waste material. The green paint so popular in the 18-19th C contains arsenic! Dust masks should be worn.

For decades, delicate mechanisms, such as watches, have been cleaned in ultrasonic baths. This is quite gentle, but rusty old locks need a more robust unit, capable of running at high volume for more than half an hour. On balance, this is not the most successful method.

Electrolytic cleaning baths are not as aggressive as abrasives, fairly cheap, and very effective. Adjusting the rate of cleaning is easy, and may be left to operate unattended if necessary, such

as overnight. It works very well on rust and takes off mill scale, though pre-cleaning with a degreaser can be useful too. The equipment needed for cleaning objects the size of locks is modest. Principally, a non-conducting leak-proof tank, such as plastic or glass; some scrap iron (e.g. rebar), a little electricity from a 12V battery (and charger); water and washing soda, so cheap to run. An ammeter and variable resistance could be useful also. Adding some detergent washing powder to keep the oil/grease and muck in suspension in the bath makes wiping down easy. It leaves a very 'active' surface that needs to be protected promptly after cleaning and drying. Tarnished brass can actually be cleaned without supplying electricity. Immerse the brass in a boiling concentrated solution of washing soda, either in an aluminium tank, or with aluminium, such as foil, in contact with the brass. The hotter the solution, and the more surface contact, the better.

Outsides of lock cases can be painted again, although it is impractical to re-apply black japan (brown varnish), which was a stoved finish. Gloss or matt black paint can be used, as desired. Hammerite® paint, either hammered or smooth finish, can be a passable modern substitute for the old finishes, and can even be applied to rusty surfaces. (It is unsuitable for valuable heritage locks, being difficult to remove.) Insides of lock cases, and components, can be protected with microcrystalline wax. This is supplied commercially as Renaissance Wax, and also Cosmolloid 80H. Renaissance Wax was originally formulated in the British Museum research laboratories in the early 1950's. It is now made solely by Picreator Enterprises Ltd, in a paste consistency for rubbing. It can be diluted with various solvents, to consistencies suitable for applying by brush, or spraying. A cheap airless sprayer suffices for small jobs. It can be applied to protect all metals, also wood and leather. It leaves a smooth, dry, matt surface, but is not as resistant to handling as lacquer, which is the ideal finish for polished brass. Diy lacquering is rarely as successful as having it done – electroplaters will usually do it.

When it comes to re-assembling locks, it is desirable to treat all parts and the inside of the case with something that will prevent corrosion, and also provide lubrication for moving parts. In the past, a water-soluble oil was useful for protection, but provided no lubrication. Today, WD-40, a water-dispelling agent available in spray cans, could do the same. Powdered graphite provides a dry lubricant but no corrosion protection.

When it come to lubrication, there is no ‘best buy’, plenty of different good choices, and a few poor ones.

DM-90 Dry Moly spray is a solid dry film lubricant containing molybdenum disulphide which is resistant to corrosion, and ideal for use on surfaces that are not suitable for liquid lubrication. DM-90 does not attract dirt and dust as it dries to a non-oily, non-sticky finish, black in colour. There are also similar products which are white.

SP-90 silicone lubricant spray is a superior dry lubricant formulated to provide extra performance and maximum silicone release. SP-90 provides a quick drying time and is clean and easy-to-use, and provides protection against corrosion. SP-90 is non-staining and has low odour.

However, probably the most popular all-round choice today is GT85, which contains PTFE (better known by the trade name Teflon®). This acts as a long lasting coating giving excellent lubrication. Available in spray cans, or larger pump containers, it is a powerful penetrating and corrosion protective non-oily spray, a dry film lubricant for precision parts, and it dissolves and cleans the toughest gunk. It is also a water displacer. As a compliment to GT85, SG85 is a white grease, which also contains PTFE. Available in a handy aerosol, SG85 is the easy and clean way to apply long-term protective lubrication on all metal contact moving parts. It sticks better than petroleum grease containing detergent, the usual type of automobile grease.

Damaged keyholes

A common problem of old locks is rusting around the keyhole. If the pin of a key is not adequately supported as it turns, there is likely to be a problem achieving smooth operation even with the correct key. Also, even the correct key which turns in an oversize keyhole can damage the wards of a lock. In the 19th C some better locks hade a brass plate on the keyholes, to prevent rusting. Because the lockcase is thicker at the keyhole, such locks need keys with more throat. For the many locks without a brass keyhole bush, repairs are possible.

Usually only the outside keyhole, (on the coverplate of rimlocks), is badly worn. If the wear is only slight, the keyhole can be 'bumped up' with a series of dot punch marks with a centre punch, around the keyhole. The keyhole of the lockcase can only be treated thus after removing the bridge ward, which is a troublesome job, but fortunately rarely needed.

For more serious erosion of the keyhole, or where the inside keyhole is worn, a piece of thin brass plate with a new keyhole may be soldered or riveted over the original keyhole. However, a quicker repair often suffices for locks where appearance is not important.

Usually the main problem is a worn round part of the keyhole, which supports the pin of the key. A steel washer of correct size can be soldered or brazed in correct position, then a slot made for the bit. The side of the washer being soldered should be rubbed first on emery paper. The lock case area also must be abraded clean. Acid flux is preferable to resin flux for this. The area should be thoroughly cleaned afterwards, then painted.

In both cases, it is necessary to fit the same thickness on both keyholes, and usually also necessary to adjust the throat of the key.

Scotch springs do not too often break (but they can weaken), though in the past replacements were readily available. If springs in old locks of common type do break, it is usually easy to contrive to fit a modern V leaf spring – there are various sizes made for locks. See the example below alongside the bridge ward keys. If a stronger spring is needed, two springs can be used, one inside the other. Often it will only be necessary to fix one pin to the lock case, sometimes two. Either a plain pin may be riveted in, or a small self-tapping screw could be used.

Anyone who works with pipe-key locks might have some spare drill pins available. The commercially available ones had a shoulder formed on them. If no suitable pin is to hand, one can be made by cutting a wire nail to length, (actually, a little over-long at this stage, it can be shortened later), then forming a neck on one end, by reducing the diameter of the buck-tail for a length equal to about twice the thickness of the lockcase. A lathe is the ideal tool, but not really needed. Chuck a nail in an electric drill (preferably in a horizontal stand), and form a shoulder by lightly resting a fine flat file on the nail. If the small diameter is made too long, no problem, it can later be filed/ground shorter. Drill a clearance hole in the lockcase for the small end of the pin, the *buck-tail*. Then the tail is *upset*, or *bucked* (i.e. deformed), by peening the protruding tail so that it expands to about 1½ times the original shaft diameter, with a ball pein hammer. The head will take many rapid hammer blows working in an increasing circular motion towards the outside. It might be possible to grip the pin in a vice, with the lockcase resting on the vice jaws, to keep the pin upright. If this is not possible, the end of the pin is simply rested on something sturdy to act as an anvil. Riveting with solid rivets is less used these days than in the past, but it is a basic, and very old, metalworking technique, and still has its uses.

For fitting or refitting a drill pin, there is likely to be already a hole in the lockcase or lock plate. If the hole in the lock plate is already worn over-size, it will be necessary to start with a

bigger nail. Form the buck-tail as before, then file down the pin for the key to fit on it, almost to the backplate. Leave a small upstanding collar, about 2-3mm, so the drill pin can be firmly and strongly riveted in place, but the key will not enter the lock quite fully. Then file off the very end of the key pipe until the key fully enters the lock. The collar inside the lock thus acts as an additional ward, and the repair now **adds** to the lock's security. The key thus altered will still fit any other existing locks keyed-alike with it.

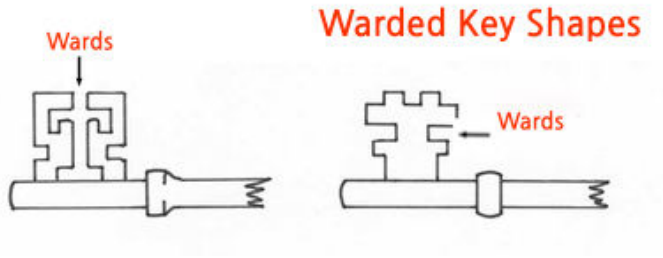
Damaged wards

Fine wards can corrode, sometimes to the point of being lost completely. This greatly reduces the lock's security, but does not stop it functioning. Fine wards can also be bent by the forcible application of a wrong key. This can then stop even the correct key operating. The problem might be detected by inspection, or it might be necessary to dismantle the lock. A clue to this is that opening is still possible by skeleton key or picking. Sometimes, a bent ward can be adjusted through the keyhole.

Stock lock removed from case, showing bridge ward – the hook ward at right bent by forcing a wrong key (Author's collection).

Locks should not be fitted upside down (a practice widely ignored by today's makers of many profile cylinders) so that the springs work against gravity – although in the past this was often done if a lock of the correct hand were not available. Also, the thrifty often re-used a lock even if of the wrong hand. On some upside down locks, mainly those with lever tumblers or a tumbler like a pocket lever, a broken tumbler spring will prevent opening.

Inspecting the keys



2 typical warded door keys (Courtesy of Capt Duncan)

On the left is a key (originally wrought iron, though modern blanks are malleable iron castings) for an antique lock with bridge ward (and also a sash ward), and on the right a modern steel key for a Union 3 lever lock with sash wards. Both of these are real keys in current use in the UK, and both of them are using the same technology to provide all or some of the lock's security: wards. (Note there might also be one or more tumblers in the lock to prevent the bolt from freely sliding; many lever locks especially older ones might also employ warding of some form. If the majority of the security is being provided by warding it would be considered a warded lock.)

Victorian bridge ward key damaged by dropping – the bottoms of the bit have broken off adjacent to a deep ward cut (below).

Keys should be inspected for wear. The front leg of a bridge ward key is quite often bent, and not infrequently broken. Sometimes it breaks off in the lock. Around the throat can wear, also the bottom of the bit – but be careful not to mistake a Barron key step for a worn key. Typically, a Barron key will have 2 (or 3) steps on each side of the bridge, with one being full height.

If the front leg of a bridge key is bent, examine it very carefully for cracks – especially at the thinnest parts by sash or collar wards. Damaged and cracked keys are prone to breaking inside the lock, causing a greater problem. Generally it is wise not to try to straighten a bent bit, especially cold, unless it is too bent to operate. If a leg has broken off but is still available, it might be possible for a restorer to pin and weld it back on, or the key might be stuck together enough to serve as a pattern for casting a new key (see below).

If a key is used always from one side of a stiff lock with a strong tumbler spring, the part of the key that moves the tumbler can wear. This can be carefully built up again by welding, if necessary. The same can happen if the bolt binds in its staple, until the bolt is no longer thrown fully. Such a worn key will need to be either repaired or replaced, and repair is usually easier.

Pipe keys can become clogged with dirt and be unable to enter the lock, although correct. The pipe can be cleaned to ensure that the key can enter the lock fully.

Old iron keys commonly and naturally acquire a brown finish. If much handled, this will be smooth and somewhat protective – it is the same 'brown' finish formerly applied to guns by the use of acid solutions. Many iron and steel keys (but not plated ones) and small parts such as screws will turn blue if heated – then quenched in oil and when cool, rubbed dry. This heat bluing process looks nice, gives some protection, and lasts fairly well. To avoid changing the metallurgy of the key, there are cold bluing solutions/creams, available from gun shops. Brownells Oxpho® blue cream is reckoned to be one of the best by many shooters. I haven't used it; but what I used seems no longer available.

Another idea is phosphating. This was developed early in the 20th C as an industrial rust-proofing treatment for steel. It is now widely used by motorists. Use the original Jenolite® liquid, according to instructions. There is a non-drip version often sold to motorists, but it leaves a surface residue which is better avoided. The result depends on the metal and how clean it is; it varies from an even black to a pleasing mottled grey/black, similar to hammer-tone effect.

Cutting keys

It is all too common for bridge ward keys to be damaged by careless handling. When dropped, they tend to fall on the nose – the front bottom part of the bit, which can bend or break (see above).

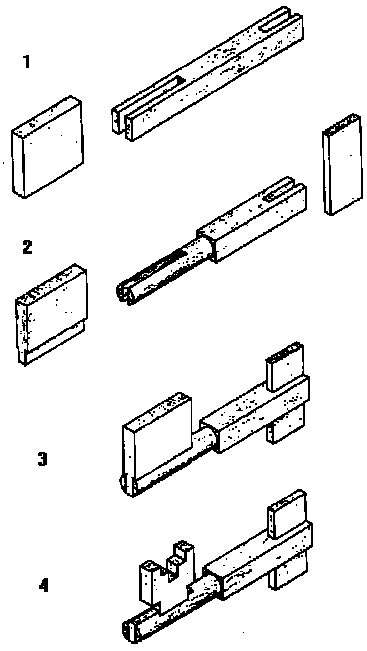
Most large blanks supplied today are malleable iron castings, rather than forged blanks. Blanks big enough for rim locks often already have bridge and collar ward cuts, which can be a help. However, not always an unqualified help – see below. It might be necessary to cut through a sprue at the bottom of the bridge ward cut. Cutting ward keys is often a slow task requiring much patience. A late-19th C writer noted that a locksmith would be expected to fit a warded key to a common lock (including cleaning and any repair needed) in two hours – although he would have available an assortment of pre-cut keys, so might need to do little, even no, actual cutting.

There is a significant difference between keys for locks with movable detainers and warded keys. On the former, all the cuts are needed to make the key work its own lock. On a warded key, the cuts are made carefully, because what remains is there mainly to stop the key working *other* locks than its own.

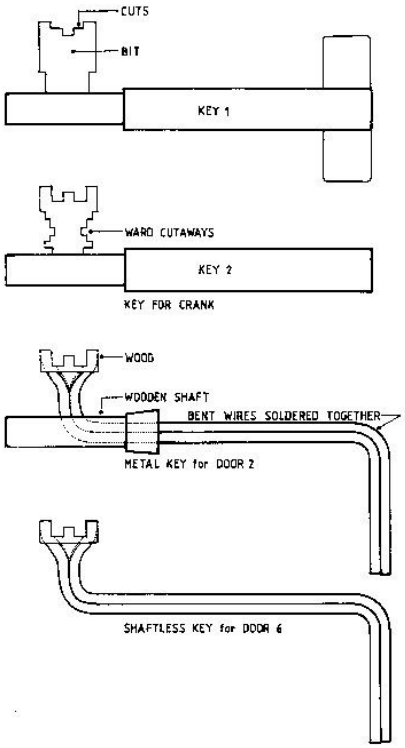
If a customer has a good working key to a warded lock but wants one or more additional keys, especially to large warded locks such as church door locks, consider ordering a bronze casting. Large blanks for warded locks are now difficult to find, and expensive – and mostly are malleable iron castings. Cutting wards must be done mainly by hand, and is often an exacting and slow process. Specialist bronze casters can cast one or more keys in bronze which will be strong, look good, and work well usually with little fettling needed. Many common bronze alloys have the unusual and desirable property of expanding slightly just before they freeze, thus filling in the finest details of a mould. Compared with how long it takes to copy a key by hand, the cost might be a pleasant surprise. However, most casters have a cycle of mould-making, casting, and fettling, so it might be necessary to wait for a key. If it is necessary to fit a key, or fettle a casting, it is almost necessary to have the lock available, and impression the key. (There was an article on impressioning keys to warded locks in *Locks & security monthly*, issue 2, Oct 2010, pp31-32.)

If a suitable blank cannot be obtained, and it can be a problem finding large blanks, 'Oldlock' has some suggestions on his website here:

http://www.oldlocks.com/making_bit_key_blanks.htm



Stages of construction of wooden keys



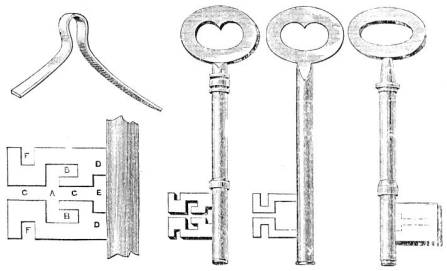
Stages in making keys – the prisoners used wood successfully, but metal is stronger.

Wood and wire prison keys improvised by prisoners, 1970's.

Some South African terrorist prisoners made prison keys from wooden dowel, slotted to take plywood bits and bows. They made a successful escape. The same method can be used in metal, and can make a strong key.

Engineers' blue can be used for marking the key blank, but the customary method was smoking in a candle flame. This is a use for all the old Christmas etc. candle stubs. The smoky flame from a kerosene lamp can also be used.

Tools needed are certainly a set of warding files, with handles; needle files, and a few larger files for rough work. A key saw is useful, and an Abrafile can speed some intricate cutting. The old method made much use of small cold chisels – but then, tungsten carbide Abrafiles (now usually known as 'rod saws') were not available. There are also tungsten carbide saws, rigid and flexible, such as Perma-Grit. (Small sizes are made for model makers, useful for cutting small warded cabinet keys.) Sash wards can often be cut on a lever key machine. Drills and small cutting wheels in a craft machine such as the Dremel can also be useful.



Bridge ward keys: stages in cutting a bridge ward key; a complete key from the 19th C; a skeleton to pass that key's lock; a blank with bridge and collar ward. At top left is an example of a flat steel V-spring for locks.

Take care when using both hand and machine tools. Eye protection from safety spectacles, and gloves, can easily and cheaply protect from injuries which could be painful – or worse! Injuries could hamper your ability to earn a living! Use a good light, and have a magnifying glass handy. If using a candle or oil lamp to smoke keys, have a fire extinguisher handy.

Blanks made with a bridge and collar ward cut (far right above) might be available. If so, it is important to check the throat is adequate, and that the bridge is in the middle of the bit. This can be a problem with locks having an escutcheon plate on the keyhole, as many better rimlocks do, to protect the keyhole from rusting. The same problem can also occur if the keyhole has been repaired by adding a washer.

The blank should be smoked, to find an impression of where exactly the wards are. If only a complete blank is available, it might be advisable to drill a small hole at A (below left). Then the hook wards BB can be cut. Originally this would have been done on an anvil with small cold chisels, but today, files or tungsten carbide saws are easier. The risk with cast keys, especially those cast with a bridge and collar ward, is that the bit might break at either of the points D. If the lock has solid wards, the middle of the bit can often be quickly roughed out by drilling a larger hole at A.

Then the bridge ward CC, and the collar ward E are cut, using saw or file, as convenient. If the sash wards FF are actually present, the ward cuts are easily cut with file or saw, taking care to cut no deeper than necessary, and just wide enough, because the bit is weaker here. Indeed, many larger keys have a thick bit, precisely to make the bit stronger.

If opening only is needed, and sash wards actually are present, the skeleton key (middle) can be made, after taking an impression to locate the wards. Such a key needs to be used gently, being rather easily broken.

Opening

In the modern world where thieves no longer carry the relatively large and specialized picking tools which were needed in the past, a good warded lock with a strong spring might today offer better security than it did two centuries ago.

Still, some locksmiths will be called on to open warded locks. In the last couple of months, I have been asked to open two – and I'm retired. A new owner of an 1880's house in the countryside found he had no key to the cellar. And access to the storeroom in a village community centre (also 1880's) was needed whilst the keyholder had gone away for the weekend, with the key. In practice, however, most of the locks which have to be opened will be of late 19th – early 20th C, and rarely of the best quality.

There are three methods of opening warded locks non-destructively.

If opening only is needed, a *skeleton key* is generally best, and a selection of suitable types will cover most locks which might be met. If a working key needs to be provided, this is made by *impressioning*, as described above. If no suitable skeleton is available, warded locks can usually be *picked.* However, because they often have very strong springs, and can be stiff with dirt and rust, it is not always easy to use wires that are strong enough. Impressioning can be used to guide making a skeleton key.

Not all old rim locks are warded locks, and not all locks with wards rely solely on wards. There are numerous other types of locks from the 19th C onwards which one might be lucky (or unlucky) enough to encounter. Most are uncommon, but one which is less uncommon is the Barron lock.

London locksmith Robert Barron obtained BP1200 of 1778 for the principle of all modern security locks: the double-acting movable detainer. This is the direct ancestor of all today's lever locks. Barron's patent described two lever-type realisations of his principle. Barron himself (and his son after him) used only one of these realisations, the one normally associated with his name. It would prove less successful technically and commercially. In this, the 2 (or 3, or 4) tumblers (of different lengths) each have a stump, which moves through gatings in the bolt tail.

Barron considered two double-acting tumblers sufficient for security, and most Barron-type locks have only two. Locks with three or four have been made, but are rare. They are only likely to be found on old strongrooms. 4 tumblers is the practical limit. Using levers of the other realisation, later associated with the name of Chubb, the only limitation is the thickness of the lockcase.

After the patent expired, it could legally be copied by anyone, and Barron-type locks continued to be made in Willenhall up to 1939. Most were cabinet and padlocks. Door locks seem to have ceased to be made in numbers from the 1830's – 1840's, as it was soon found they were not as secure as Barron believed! Although they were cheaper than most of the other patent locks available. Indeed, the survival of door locks is fairly uncommon, because many were later converted to 'Chubb-type' pocket levers.

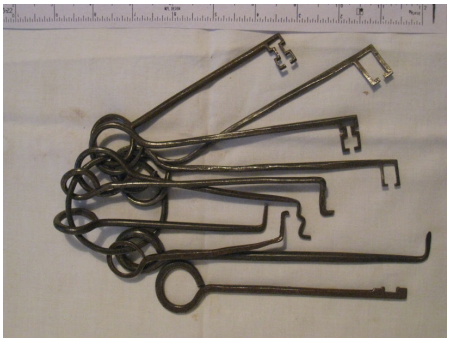
Most Barron locks have hook wards. Note that in single-sided locks, the bolt is nearest the keyhole, with the tumblers under it. Thus the longest (bolt) step is nearest the key bow. This is the opposite of how most lever locks are arranged. Double-sided Barron locks have a bridge ward, and 2 levers. Although the Bramah cylinder lock, with its distinctive small keyhole, appeared in 1784, and the Chubb detector lever lock in 1818, these high quality locks were

expensive and scarce. The Chubb was always more numerous than the Bramah, but examples earlier than mid- to late-1820's are rare.

If a lock looks like a rimlock with a bridge ward, and a skeleton key enters and turns part way, and finds spring pressure but will not turn completely, suspect a Barron lock. Then probe for 2 (instead of the usual 1) spring-pressed levers, in addition to the bolt. Barron locks will need to be picked like simple lever locks. The difference in heights of steps is not large in Barron locks. Key-making is straight-forward, though cutting the wards is time-consuming. The combination of wards and movable detainers together is more effective than either separately. Barron door locks were fitted mainly in the period from last quarter of the 18th C through the 1820's, although other locks, especially cheap padlocks, continued to be made until later.

Opening: skeleton keys

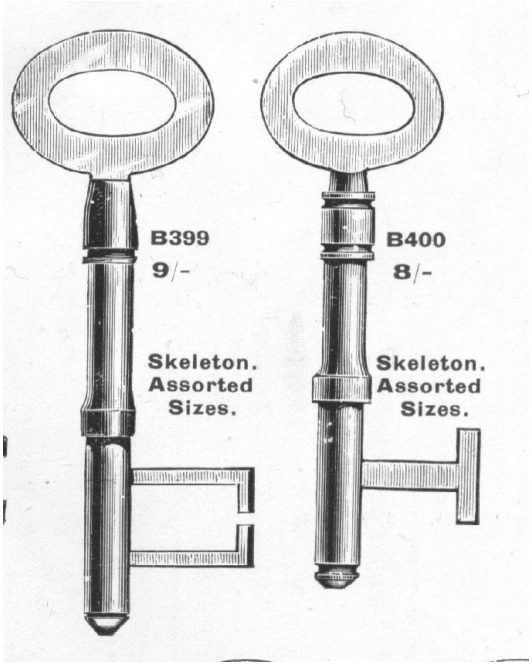
A selection of skeleton keys in various sizes for bridge wards and sash wards is the best way to open most of the rim and mortice locks likely to be encountered. They can be made by skeletoning ordinary old warded keys. Removing the key's collar can sometimes extend its usefulness, but is the last part to skeleton. Skeleton keys, presumably made for burglars, or by estate blacksmiths for the estate carpenter, sometimes appear for sale. My set came from an old burglar, via a retired policeman. They sometimes appear in estate sales, and antique shops, and French eBay.



Blacksmith-made skeleton keys, late 19th C, left, (Author's collection)

Note that these are somewhat fragile. Several have been bent, and the bottom one has both parts of the bit broken off!

Uncommonly well-made 19C set of skeleton keys; the long curved tool is for opening Odell or 'french' latches, common from Georgian times to mid 20th C, especially on common stair doors of old Scottish tenements (right).



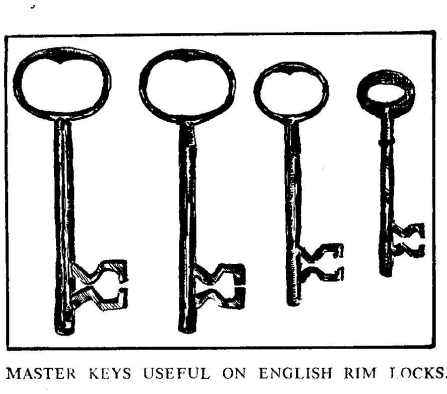
Original 19th C rimlock keys skeletoned, above. (Author's collection

Bridge ward skeleton on left, (above) sash ward mortice skeleton on right. Commercially supplied skeleton keys by the dozen, showing 1920's prices. Most rim keys were supplied, 'wards well assorted', up to 10". Some were also made in 11" and 12"! (interwar catalogue illustrations courtesy of Keith Carrier & Co.)

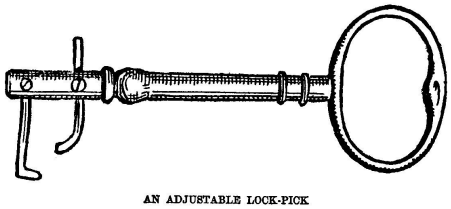
These keys have proved useful in ul for opening larger rimlocks encountered service. Some smaller ones are also useful, in places where warded locks are still in common use.

Further assortment of mainly smaller skeleton keys for mortice, rim, and lever warded locks, left. (Author's collection)

An international burglar who was caught in Germany early in the 20th C had an adjustable skeleton key which was very successful. When arrested, he asked that his skeleton key be given to Houdini, who was performing in Germany at the time.



MASTER KEYS USEFUL ON ENGLISH RIM LOCKS.



AN ADJUSTABLE LOCK-PICK

An adjustable skeleton key given to Houdini in Europe. (right).

Various different-shaped legs could be fixed in the shank. As shown, left, they could also be adjusted in height, within narrow limits.

Some more of Houdini's rim skeleton keys (left).

Locks with elaborately bulleted keyholes which will not admit even a thin flat key blank are rare in

Britain, and such would need a blank fashioned from sheet metal and suitably formed. For more modern locks with bulleted keyholes, such as are common on European locks, a set of skeleton keys including shaped bits can be bought from Multipick-Service. Numbers of European locks were imported into Britain in the early post-second war years, and so might be encountered in buildings that were renovated or altered then. Blanks for European locks are made by Silca. (There are probably more old bulleted European locks on imported old furniture than doors, but that is another story.)

Skeleton keys '**Set O'** for warded European locks, including bulleted keyholes. (Courtesy of Multipick Direct GmbH)

A look into the keyhole can usually give useful clues to start. A small torch can be helpful. This will usually show whether the lock is rim or mortice, and if mortice, whether it has a bridge ward.

Sash, collar, & wheel wards

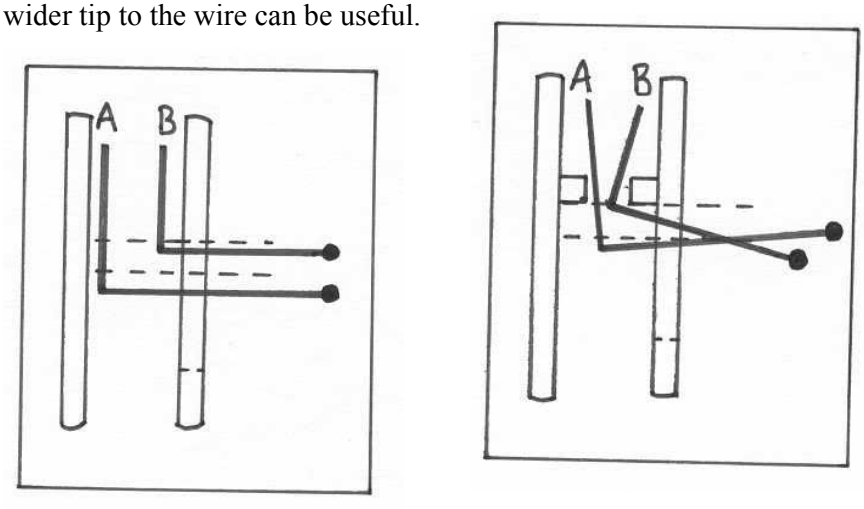
A wheel ward is a (usually fine, i.e. sheet metal) obstruction which is more or less continuous along the path of the key bit, fixed to either case, cap, or bridge. Wheel wards are often partial (incomplete circle). Solid wards on the case or cap are called sash wards; one around the key stem acting as a bush is a collar ward. A collar ward is found in many lever locks.

These may also be attached to one or both sides of a bridge ward.

A solid sash ward is an obstruction which is usually part of the keyhole bush, normally almost continuous along the path of the key bit, except where it would obstruct the bolt lathe. It might be provided either on the case, or the cap, as in some later ones, but in better door locks, and most mortice locks, on both case and cap. Collar wards are only close to the key shank, to pass a keyhole bush. Wheel wards are similar, being varieties of, usually, fine wards made of sheet metal, most often found in cabinet locks and padlocks. In single-sided locks, wheel wards may be fixed under the keyhole so a wrong key will not even fully enter the lock. However, they are commonly only partial.

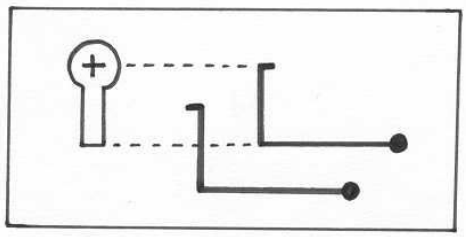
Not all wheel wards are rectangular in cross section. Some are **L**-shaped, called 'hook' wards.

For the basic lock model two "**L**" shaped wires are needed, one to slide the bolt across (at B), and one to raise the tumbler or levers to the correct height (at A). Because the bolt tail and tumbler can be quite thin, a small hook to give a wider tip to the wire can be useful.



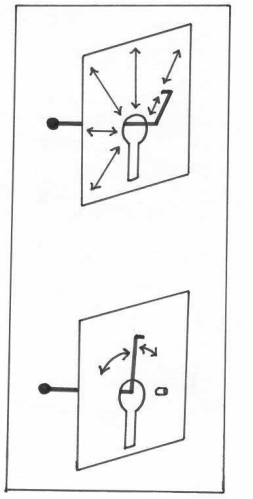
Two **L** wires to pick a warded tumbler lock; and these two basic picks will still do the job in a lock with simple warding.

The two wires can often be angled to pass through the wards, or bent at different angles



Wire ward picks with a small hook on ends, to make a broader tip, also useful for probing for wards.

If the more or less straight wires do not succeed, careful probing for other wards can find the obstruction. Sash wards in rimlocks are particularly effective at frustrating simple skeleton keys and picks. It might be necessary to shape wires specially for some locks, especially older one, which are the more likely to have complicated wards.



Using **L** pick wires to feel for wards, if a simple skeleton key does not turn.

Also, bear in mind that old locks can be very stiff, even actually stuck. And be alert to the possibility of a Barron lock.

Opening: Impressioning

It might help, with complex warding, to probe the interior of a lock which cannot be opened, and to stick a Post-it note to the door to record where the wards are felt.

The shank gauge and bit size can both be measured from the lock. Start with a suitable blank If bullet wards are present, it can be difficult to find an exact match, especially for foreign locks. Depending on the value of the lock, and the importance of opening, either the key bit might be altered, or it might be possible to remove the warding from the keyway of the lock itself. This is generally not good practice, as it reduces the security of the lock, and should not be done on valuable old locks.

Locks having an applied (usually brass) escutcheon plate on the keyhole, will require a wider throat. The bridge ward cut must be in the middle of the bit, so if the blank has a bridge ward cut already, the collar will have to be reduced. It is easier, if a wide enough solid bit blank is used, to remove some of the back edge of the blank only. Also, for technical reasons, it is not uncommon to find blanks cast already with a bridge ward cut to be defective, with blowholes in the casting only discovered as cutting proceeds!

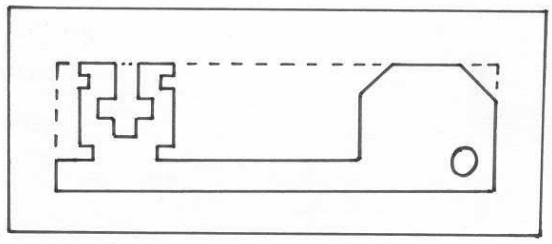
Smoke the blank over a candle flame until there is a good coating of soot. Carefully insert the blank and turn it to try to open the lock, remove the blank to see where the soot has been rubbed away by the wards. (It is recommended to have performed the probing and mapping exercise, and looking through the keyhole for bridge wards and other visible wards, as well as

reading the marks from the impress. Be aware that if the lock is double-sided, the bit will need to be a symmetrical pattern).

Using good warding files (needle files if necessary, for small keys), or other suitable tools, remove the marked areas to create gaps for the wards to pass through. Be careful not to over-do it, more can always be filed off, it is not so easy to replace the filings. Ward cuts should be only an easy clearance fit – might be less close-fitting on common locks with worn keyholes, as the key must be able to wobble slightly, and should turn easily.

Clean all the rough edges and re-smoke the key, then try, file, clean, soot, try again. This process should not be rushed, and needs much care. Do not believe there is plenty of spare metal on the key bit, always imagine that there might be one more ward further round, think about the key – where could it fit?

Refrain from cutting the top of the bitting as long as possible, because here mistakes are the least easily remedied. On modern locks there might be two or more levers – try picking these first, so as to have an idea of the key's bitting. On a lock which might be a Barron lock, there is likely to be a hook ward, and other wards, in addition to the levers. Be aware that in a Barron lock the bolt tail is nearer the cap of the lock, with the levers *behind* it.



Making a blank from a piece of flat sheet metal.

If a suitable blank is not immediately available, but a temporary key is needed for a larger lock, e.g. church door, then it might be possible to cut a flat key to do the job from of a strip of rolled mild steel sheet. There is a detailed description by a blacksmith of several methods of making key blanks at:
http://www.oldlocks.com/making_bit_key_blanks.htm

Other problems

The owner has the key but it does not work. Locks benefit from being operated occasionally. If the lock has not been used in a long time it might just be stiff and rusty, however if it were opened recently, then it is likely that a ward is damaged – possibly by use of a wrong key, or a picking attempt. Have a probe to find where it is stopping, or try to use a skeleton key. The most likely ward to be damaged is a fine bridge ward, try probing for it, although it might be quicker to soot the key and turn it to locate the problem.

What to do about a damaged ward?

If it is a bent sash ward or pin ward, it might be possible to enlarge the gap in the key to pass the bent ward. If it is broken, the ward might be moved or reshaped through the keyhole, but a skeleton is likely to be the better method of opening. Taking an impression with a smoked blank can also give clues. Usually the lock will need to be dismantled for repair. If this will cause damage, a historic lock should simply be retired. In some locks it will be necessary to break out the piece using a stout pick and brute force.

A broken tumbler spring will not normally stop the bolt being moved by the key, but might allow the bolt to be pulled out or pushed in, by hand – which is not satisfactory. It can lead to a lockout.

Several examples I have included are from churches. Britain's **churches are not museums**, but collectively they contain an enormous amount of our cultural heritage, going back to Saxon times. In a sense, they belong to all of us, even those who are not Christians, and it behoves us all to care for them and preserve them as works of art for the nation. Many of them contain freely accessible examples of ironwork, locks, chests, and stained glass – look especially at churches dedicated to St Peter. Churches require endless skilled and expensive repairs.

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Acknowledgements:
Several individuals and companies have contributed assistance and advice with text and illustrations. They include Keith Carrier & Son, Capt Duncan, the late Jim Evans (Arthur Hough & Sons Ltd), Peter Hall, Mick Hanzlik, David Key, Multipick Direct GmbH, 'Oldlock', George and Val Olifent (The Keyhole). And the many other locksmiths with whom I have chatted through the years.

Further reading and a few sources of help

OLIFENT, Valerie: The ancient art of the locksmith. *Historic Churches*, 2001 Cathedral Communications Limited, Tisbury.
available online at http://www.buildingconservation.com/articles/locks/locks.htm

ASHURST, John *and* Nicola: *Practical building conservation Vol 4: Metals.* English Heritage Technical Handbook, Gower Technical Press. 1988

The most readily obtainable book on old locks and keys is the small book,
MONK, Eric: *Keys, their history and collection.* Shire Publications. (various editions)

Some libraries will have
ERAS Vincent J M: *Locks and keys throughout the ages*. Bailey & Swinfen, 1957.

A book of basic blacksmithing and whitesmithing techniques, useful for learning to repair or make locks:

STREETER, Donald: *Professional smithing: traditional techniques for decorative ironwork, whitesmithing, hardware, toolmaking, and locksmithing.*

(Several of the above books have been published or reprinted in several editions.)

http://www.lockpicking101.com/viewtopic.php?f=9&t=7620&sid=99d06b4a453f5ceb08e15f6cda9b1ecc#wrapheader

Oldlock's websites are sites for blacksmiths, but have several pages on locks and keys, useful for repairers of old locks, or even for making handmade locks:

http://www.oldlocks.com/making_bit_key_blanks.htm

http://anvilfire.com/iForge/tutor/jd_locks/

Internet links on electrolytic cleaning:
http://users.eastlink.ca/~pspencer/nsaeta/electrolysis.html

The above link is now dead, but the paper can still be found here

https://www.scribd.com/document/106032945/Electrolysis-Cleaning-Method

Note that electrolysis can only be used to clean rusty/corroded METAL, it can destroy or damage other materials.

http://wiki.vintagemachinery.org/Default.aspx?Page=RustRemovalByElectrolysis&AspxAutoDetectCookieSupport=1

There are many Internet sources of information on electrolytic cleaning, blacksmithing, and more modern forms of welding, which might be useful.

Although new wrought iron is no longer made, stocks still exist from demolished old buildings and structures such as bridges etc. There are blacksmiths who can repair or copy old designs of lock furniture. Try making contact through the British Artist Blacksmiths Association: Secretary Tim Mackereth work/fax 01526 830303
http://www.baba.org.uk/

Richard Phillips 2014, with some later amendments.